HUC 10290106 – Turnback Creek and tributary to Goose Creek
Water body IDs: 1414 and 1420
303(d) Listing: Escherichia coli

Total Maximum Daily Load

Implementation Strategies

for the

Turnback Creek and Tributary to Goose Creek TMDL Lawrence and Dade Counties, MO

Pollutant: *Escherichia coli*

Completed: September 3, 2021

Prepared by: Water Protection Program, Watershed Protection Section

WATER BODY SUMMARY
Total Maximum Daily Loads (TMDL) for Turnback Creek and Tributary to Goose Creek
303(d) Listing: *Escherichia coli (E. coli)* Bacteria

Water Body Identification (WBID), Hydrologic Class, and TMDL Development Prioritization:[1]

Turnback Creek	1414	Class P	High Priority
Tributary to Goose Creek	1420	Class C	High Priority


Location of watershed in Missouri

Location: Lawrence and Dade Counties

8-digit Hydrologic Unit Code (HUC):[2]
10290106 – Sac River

12-digit HUC Subwatersheds
102901060101 – Goose Creek
102901060102 – Headwaters Turnback Creek
102901060103 – Billie Creek - Turnback Creek
102901060105 – Sycamore Branch - Turnback Creek

Designated Uses:[3]
Irrigation
Livestock and wildlife protection
Human health protection
Protection and propagation of fish, shellfish, and wildlife
- Warm water habitat
- Cold water habitat (Turnback Creek)

Recreation in and on the water
- Whole body contact recreation category A (Turnback Creek)
- Whole body contact recreation category B (Tributary to Goose Creek)
- Secondary contact recreation

Impaired Uses:
Whole body contact recreation category A, Turnback Creek
Whole body contact recreation category B, Tributary to Goose Creek

Pollutant Identified on the 2020 303(d) List:
Escherichia coli (E. coli) (fecal indicator bacteria)

Identified Sources on the 2020 303(d) List:
Rural nonpoint sources

Length and Location of Impaired Segments:
WBID 1414: 19.9 miles, from Section 35, Township 30N, Range 26W to Section 24 Township 28N, Range 25W
WBID 1420: 3.0 miles, from mouth to Section 18, Township 28N, Range 25W

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[1] For hydrologic classes see 10 CSR 20-7.031(1)(F). Class P streams maintain permanent flow even in drought periods.

[2] Watersheds are delineated by the U.S. Geological Survey using a nationwide system based on surface hydrologic features. This system divides the country into 2,270 8-digit hydrologic units (USGS 2019). A hydrologic unit is a drainage area delineated to nest in a multilevel, hierarchical drainage system. A hydrologic unit code is the numerical identifier of a specific hydrologic unit consisting of a 2-digit sequence for each specific level within the delineation hierarchy (FGDC 2003).

[3] For designated uses see 10 CSR 20-7.031(1)(C) and 10 CSR 20-7.031 Table H. Presumed uses are assigned per 10 CSR 20-7.031(2)(A) and (B) and are reflected in the Missouri Use Designation Dataset described at 10 CSR 20-7.031(2)(E).

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1. Introduction

A total maximum daily load (TMDL) report for Turnback Creek and Tributary to Goose Creek addresses elevated *Escherichia coli* (*E. coli*) bacteria concentrations that resulted in the water body's placement on Missouri's 303(d) List of Impaired Waters. The TMDLs established for the impaired water bodies represent the *E. coli* loading capacity for each stream, which is the maximum amount of a pollutant that a water body can assimilate and still attain and maintain water quality standards. Watershed characteristics and *E. coli* loading targets can be found in the TMDL report, which is available on the Missouri Department of Natural Resources' website at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls. Although this implementation document is drafted primarily to implement the goals of the *E.coli* TMDL, this document will also address nutrient loading. Many of the practices suggested in this document will reduce both *E. coli* and nutrient loading. Questions regarding the TMDLs may be sent via email to tmdl@dnr.mo.gov or by calling the Department's Watershed Protection Section at 573-751-5723.

This implementation strategies document is a companion to the TMDL reports and suggests actions that will reduce pollutant loading in order to meet the loading capacities established in the TMDL document. The goal of the TMDLs is to attain and maintain designated uses in the water bodies. The whole body contact recreation category A use is impaired in Turnback Creek and the whole body contact B use impaired in Tributary to Goose Creek due to elevated *E. coli* concentrations in the water bodies.

This document neither prescribes nor prohibits any specific practices or technologies for reducing pollutant loading in the impaired water body and is not intended to serve as the sole means of remediation and restoration. However, the Department recognizes that technical guidance and support are critical to achieving the goals of any TMDL. Therefore, while the TMDL calculates the maximum pollutant loading that the impaired stream can assimilate and still attain and maintain water quality standards, this strategies document provides additional information to assist in meeting the TMDL loading goals including: pollutant reduction strategies, example calculations of pollutant reductions, potential participants in the watershed, and funding sources. Because the TMDL addresses pollutant loading from all potential sources in the watershed, this strategies document provides guidance for meeting the loading targets assigned to both point and nonpoint sources.[4]

Point source pollutant loading controls are implemented primarily through the Missouri State Operating Permit program.[5] Effluent limits are established in facility permits based on the assumptions and requirements of the wasteload allocations and other recommendations in the TMDL documents. Cost-share loans are available from the State Revolving Fund and are administered through the Department's Financial Assistance Center to help finance facility upgrades that are necessary to meet more stringent effluent limits.

Watershed management practices that reduce nonpoint source pollutant loading are conducted voluntarily by interested stakeholders and landowners within the watersheds. In accordance with Section 319 of the federal Clean Water Act, the U.S. Environmental Protection Agency (EPA)

[4] Point and nonpoint sources are defined and discussed in Sections 5.1 and 5.2 of the TMDL report for Turnback and Tributary to Goose Creeks.

[5] The Missouri State Operating system is Missouri's program for administering the federal National Pollutant Discharge Elimination System (NPDES) program. The NPDES program requires all point sources that discharge pollutants to waters of the United States to obtain a permit. Issued and proposed operating permits are available online at dnr.mo.gov/env/wpp/permits/index.html.

provides funding for nonpoint source pollutant load reduction practices. Section 319 nonpoint source subgrants are administered through Missouri's Section 319 program to assist organizations with watershed planning or implementation of activities as described in a Nine Element Watershed Management Plan (or alternative plan under certain specific conditions) that has been accepted by the Department and EPA. The Nine Key Elements of a Watershed Management Plan are provided in Appendix A. More information on Missouri's Section 319 subgrant program is available at: dnr.mo.gov/water/what-were-doing/nonpoint-source-pollution-section-319. Local communities and citizens looking to develop watershed plans to improve water quality are encouraged to contact the University of Missouri Extension at 573-882-0085. Information regarding the University Extension's soil and water program is available online at extension.missouri.edu/find-your-interest/agriculture-and-environment/agricultural-systems-and-natural-resources/soil-and-water. Additional cooperating organizations and sources of funding are provided in Section 11 of this document.

2. Watershed Characteristics

Turnback Creek and Tributary to Goose Creek are located in southwest Missouri within the Sac River sub-basin, which is cataloged by the U.S. Geological Survey (USGS) as the 8-digit hydrologic unit code (HUC) 10290106. Within this sub-basin, the 19.9-mile impaired segment of Turnback Creek (WBID 1414) receives runoff from a 135.4 square mile watershed comprised of three 12-digit HUC watersheds (102901060101, 102901060102, 102901060103) plus 46 percent of 12-digit HUC 102901060105. The impaired 3-mile Tributary to Goose Creek (WBID 1420) receives runoff from a 4.75 square mile area within 12-digit HUC watershed 102901060101. Figure 1 displays the Turnback Creek and Tributary to Goose Creek watersheds.

The Turnback Creek and Tributary to Goose Creek watersheds are located within the Osage ecological drainage unit, which falls within the Ozark Highlands, covering portions of central and southwestern Missouri (MoRAP 2005). Like most streams in the Ozark Highlands subregion, streams in the Springfield Plateau Level IV ecoregion occupy narrow valleys separated by steep narrow ridges with clear water, high base flows, and low suspended sediment loads. Streambeds consist mainly of chert gravel and sand. Well-defined riffles, gravel bars, and bluff pools are prevalent. Extensive stretches of bedrock channels are also present. Cliffs and streamside bluffs are common. Steep slopes combined with moderate to slow soil infiltration rates result in frequent flash-flooding during and after intense rainfall events (MoRAP 2005). The Springfield Plateau Level IV ecoregion is underlain by limestone formations. Surface waters are influenced by groundwater from the many springs. There are also numerous losing streams that drain to the subsurface. Tributary to Goose Creek is a losing stream.[6] There are numerous other losing streams in the upper part of the Turnback Creek watershed. Locations of gaining and losing streams and springs are displayed on Figure 2 of the TMDL document.

[6] In Missouri, a losing stream is defined in 10 CSR 20.7031(1)(O) as a stream which distributes 30 percent or more of its flow during low flow conditions through natural processes, such as through permeable geologic materials into a bedrock aquifer within two miles flow distance downstream of an existing or proposed discharge.

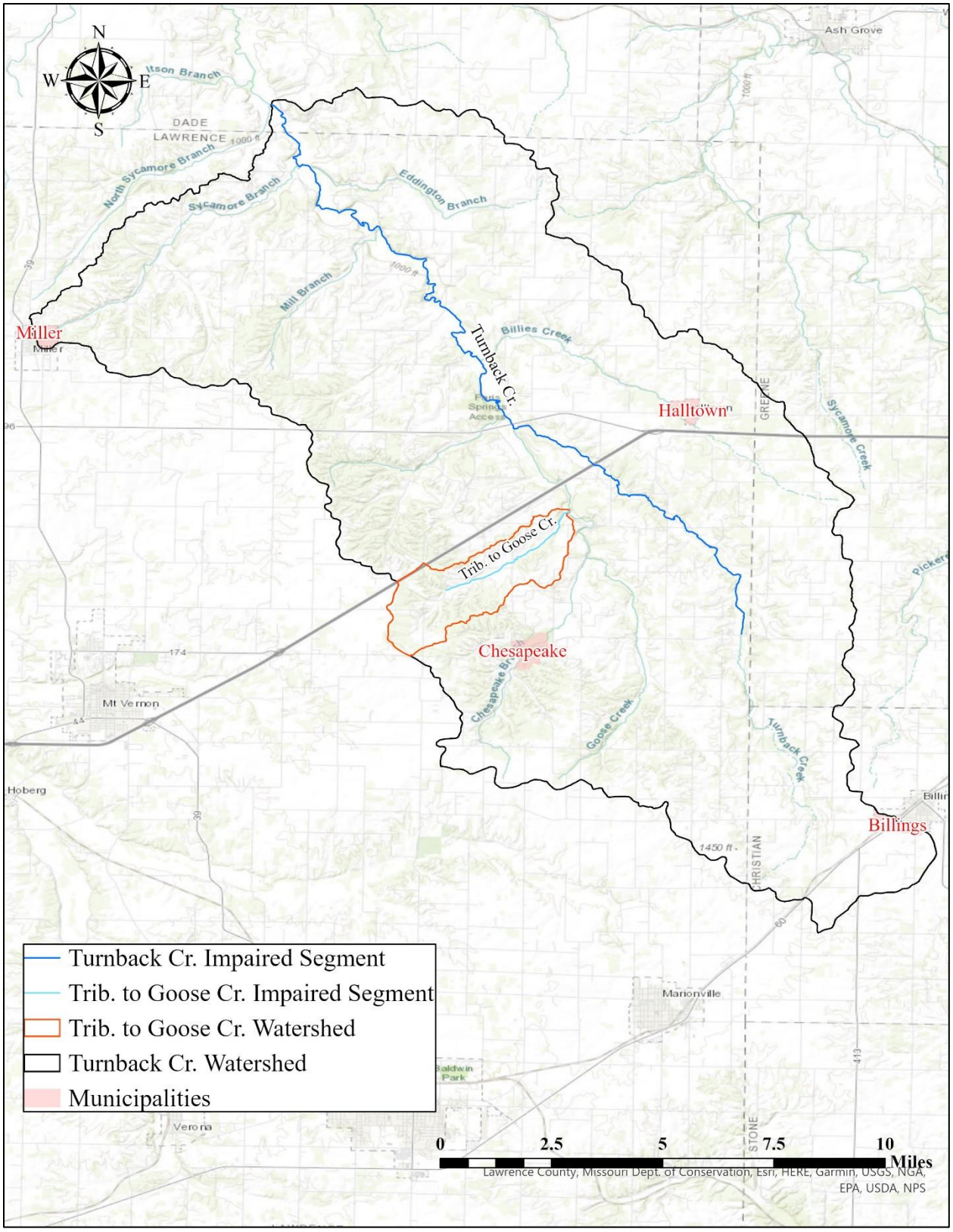

Figure 1. Turnback Creek and Tributary to Goose Creek watersheds and impaired segments.

Land cover types present in the Turnback Creek and Tributary to Goose Creek watershed are summarized in Tables 1 and 2. Figure 2 depicts the distribution of the land cover types throughout the watershed. Grassland and pasture areas potentially used for livestock grazing cover approximately 59 percent of the Turnback Creek watershed and approximately 48 percent of the Tributary to Goose Creek subwatershed.

Table 1. Land Cover in the Turnback Creek watershed

Land Cover Type	Area Square miles	Percent
Developed, High Intensity	0.03	0.03%
Developed, Medium Intensity	0.28	0.21%
Developed, Low Intensity	1.41	1.04%
Developed, Open Space	4.88	3.61%
Barren Land	0.36	0.27%
Cultivated Crops	0.97	0.71%
Grassland and Pasture	79.66	58.83%
Shrub and Herbaceous	1.67	1.23%
Forest	45.38	33.52%
Wetlands	0.66	0.49%
Open Water	0.10	0.07%
Totals	135.40	100.00%

Table 2. Land Cover in the Tributary to Goose Creek watershed

Land Cover Type	Area Square miles	Percent
Developed, High Intensity	0.002	0.03%
Developed, Medium Intensity	0.024	0.50%
Developed, Low Intensity	0.009	0.18%
Developed, Open Space	0.162	3.41%
Grassland and Pasture	2.275	47.95%
Shrub and Herbaceous	0.070	1.47%
Forest	2.189	46.14%
Wetlands	0.015	0.31%
Totals	4.744	100.00%

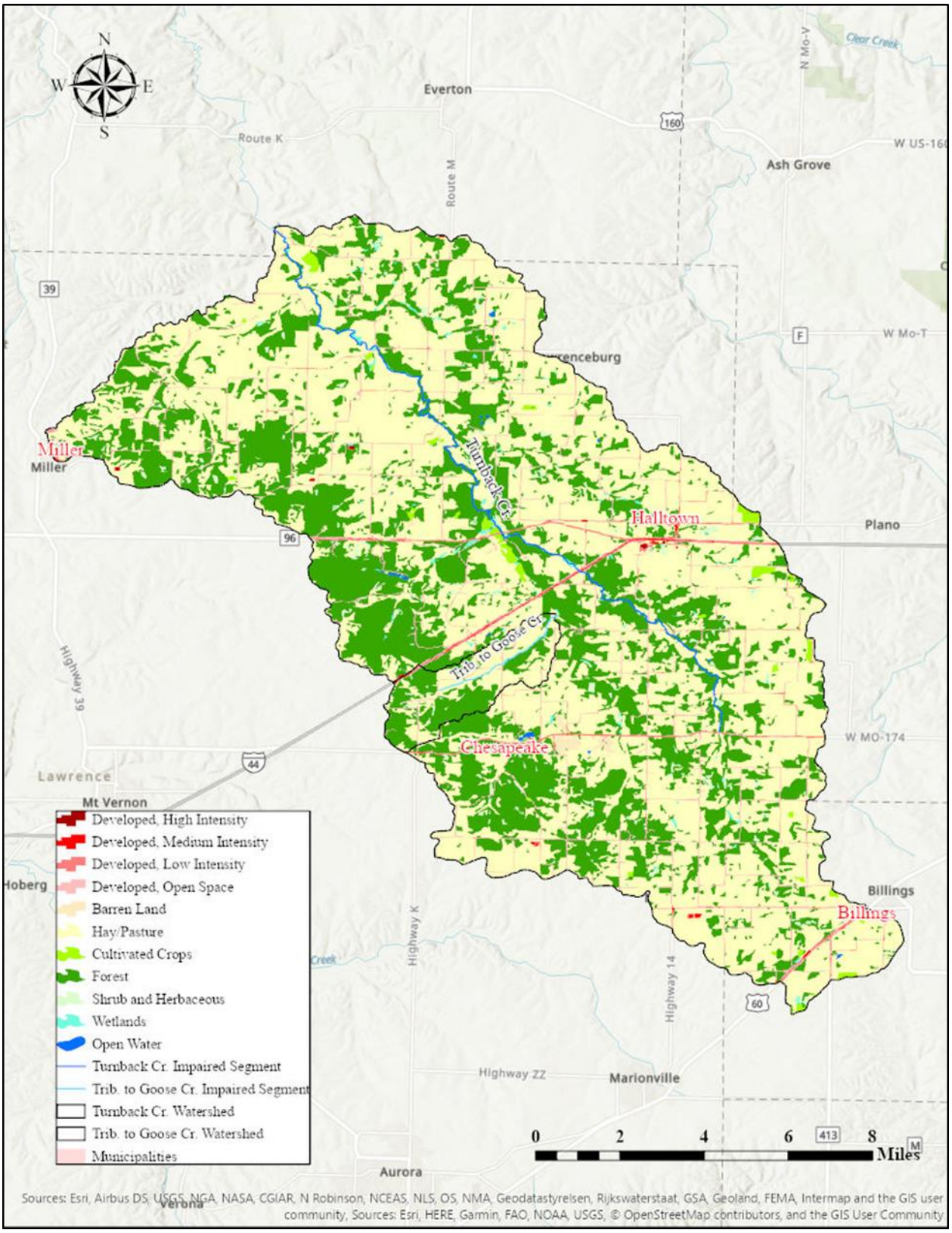

Figure 2. Land cover in the Turnback and Tributary to Goose Creek watersheds.

3. Water Quality Impairments

The whole body contact recreation category A (WBC-A) designated use is impaired in Turnback Creek and the whole body contact recreation category B (WBC-B) designated use is impaired in Tributary to Goose Creek due to high *E. coli* bacteria concentrations. Whole body contact recreation includes activities that involve direct human contact with waters of the state to the point of complete body submergence (10 CFR 20-7.031(1)(C)2.A.). During whole body contact activities, such as swimming, accidental ingestion of the water may occur and there is direct contact to sensitive body organs, such as the eyes, ears, and nose. WBC-A applies to waters that have been established by the property owner as public swimming areas and waters with documented existing whole body contact recreation uses by the public (10 CSR 20-7.031(1)(C)2.A.(I)). WBC-B applies to waters designated for whole body contact recreation not contained within category A (10 CSR 20-7.031(1)(C)2.A.(II)). Secondary contact recreation, which includes activities such as boating, fishing, and wading, are activities that may result in contact with the water that is either incidental or accidental and the probability of ingesting appreciable quantities of water is minimal (10 CSR 20-7.031(1)(C)2.B.). The secondary contact recreation uses are not impaired in Turnback Creek and Tributary to Goose Creeks.

Water quality criteria represent a level of water quality that supports and protects particular designated uses. Water quality criteria are expressed as specific numeric criteria and as general narrative statements. Missouri's Water Quality Standards (10 CSR 20-7.031(4) and (5)) establish general criteria applicable to all waters of the state at all times and specific criteria applicable to waters contained in 10 CSR 20-7.031, Tables G and H. Specific numeric *E. coli* bacteria criteria are given in Missouri's Water Quality Standards at 10 CSR 20-7.031(5)(C) and Table A1. For whole body contact recreation category A waters, *E. coli* concentrations during the recreational season (April through October) shall not exceed the geometric mean of 126 colony forming units (cfu) per 100 milliliters (mL) of water and whole body contact recreation category B waters shall not exceed the geometric mean of 206 cfu/100 mL of water. These criterion are also protective of secondary contact recreational uses. The Department determines that a stream is impaired for *E. coli* bacteria when the water quality criteria are exceeded in any of the last three years for which there is a minimum of five samples collected during the recreational season. This approach is detailed in the Department's 2020 Listing Methodology Document, which is available online at dnr.mo.gov/env/wpp/waterquality/303d/303d.htm.

Sufficient data consistent with the assessment methodology are available to support these listings as summarized in Table 3 and Figure 3. As shown, *E. coli* concentrations exceeded the geometric mean of 126 cfu/100 mL during the recreational season in Turnback Creek in 2007, 2008, and 2012. Tributary to Goose Creek exceeded the 206 cfu/100 mL criteria during the 2007 recreational season.

Table 3. Summary of recreational season *E. coli* data for Turnback and Tributary to Goose Creeks

Water Body	Recreational Season	Number of Samples	Minimum (cfu/100 mL)	Maximum (cfu/100 mL)	Geometric Mean (cfu/100 mL)
Turnback Creek WBID 1414	2007	10	44	365	155
	2008	5	101	435	232
	2012	8	59.8	4,840	263

Water Body	Recreational Season	Number of Samples	Minimum (cfu/100 mL)	Maximum (cfu/100 mL)	Geometric Mean (cfu/100 mL)
Tributary to Goose Creek WBID 1420	2007	6	114	727	323

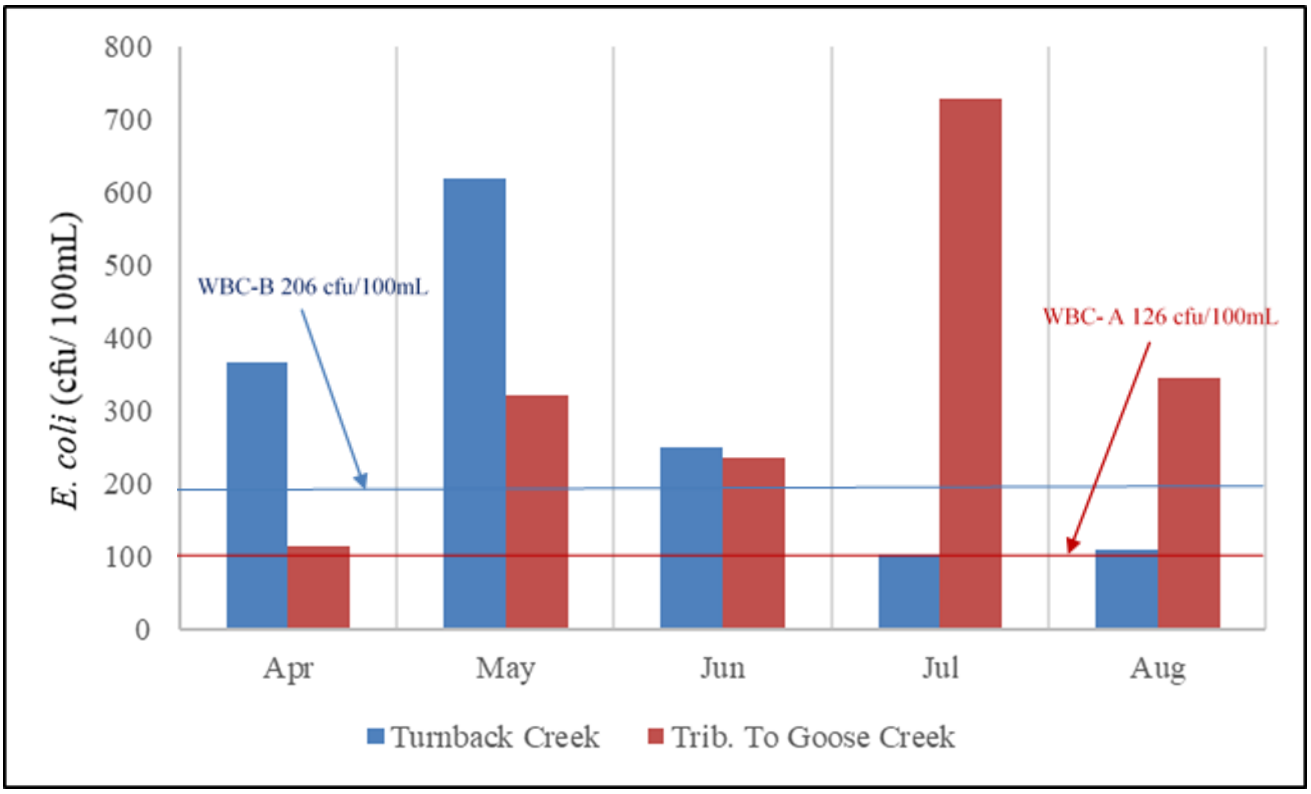

Figure 3. Geometric Means of *E. coli* Data

4. Causes and Sources of Pollutant Loads

4.1 Agricultural Areas

Croplands, pasturelands, and low-density animal feeding operations are potential sources of bacteria in surface waters. Bacteria are transported in runoff from areas fertilized with animal manure and where livestock are present. Runoff can result from precipitation or excessive irrigation. Section 640.760 Revised Statutes of Missouri (RSMo) establishes setback distances for surface application of liquefied manure from a concentrated animal feeding operations (CAFOs) by a third party.[7] Pursuant to Section 640.760 RSMo, the Department may enforce stricter setbacks. Soil and Water Conservation Districts provide funding and guidance for the development of nutrient management plans for private lands. Areas where nutrient management plans guide manure application and where

[7] Section 640.760 RSMo setback distances are: 50 feet from a property boundary, 300 feet from any public drinking water lake, 300 feet from any public drinking water intake structure, 100 feet from any perennial and intermittent streams without vegetation abutting such streams, and 35 feet from any perennial and intermittent streams with vegetation abutting such streams.

best management practices (BMPs) are used to reduce soil erosion contribute less bacteria to surface waters than unmanaged areas. Although grazing areas are typically well vegetated, livestock tend to congregate near feeding and watering areas and create barren areas that are susceptible to erosion (Sutton 1990). Livestock that are not excluded from streams deposit manure and thus bacteria directly into waterways.

As shown previously in Tables 1 and 2, and Figure 2, the Turnback Creek and Tributary to Goose watersheds are predominately pastureland, comprising a total of 79.7 square miles. Aside from livestock present in permitted CAFOs, the exact type and numbers of livestock present in the Turnback Creek and Tributary to Goose Creek watersheds is unknown. The number of cattle in the watershed can be estimated from county cattle population numbers provided in the U.S. Department of Agriculture's 2017 Census of Agriculture (NASS 2017). Based on the 2017 agricultural census there are an average of 148 cows per square mile of grassland or pasture in Dade and Lawrence counties.[8] This indicates that there are 20,067 cattle in the Turnback Creek watershed (this includes the Tributary to Goose Creek watershed as it lays within the boundary of the Turnback Creek watershed).

The U.S. Department of Agriculture estimates that a 1,000-pound beef cow produces approximately 59.1 pounds (26.8 kilograms) of manure per day (USDA 1995). Another study found that 1 gram of fresh manure from a cow on pasture contains a population of approximately 758,577 *E. coli* (Weaver et al. 2005). A single *E. coli* cell can grow into a colony containing 10^8 cells every 12 hours (Lodish et al. 2000). This means that each 1,000-pound cow has the potential to produce 422 colony forming units per day. Other types of livestock such as horses and sheep may also be contributing bacteria loads in the Turnback Creek and Tributary to Goose Creek watersheds. The number and distribution of other animals in the watershed is unknown.

4.2 Riparian Corridor Conditions

Riparian corridor conditions have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in the attenuation of pollutants in runoff. Land cover within 100 feet of streams in the Turnback Creek and Tributary to Goose Creek watersheds are presented in Table 4. Agricultural areas (cropland and pasture) constitute approximately 47 percent of the riparian corridors of streams in the Turnback Creek watershed. These areas may be more susceptible to *E. coli* loading. Forty-two percent of the riparian corridors are forested. This indicates that some *E. coli* transported from adjacent cropland and pasture lands into those areas may be intercepted before it enters the streams.

[8] This analysis assumes all areas identified as grassland or pasture are being used for cattle grazing and that cattle are evenly distributed among those areas. Additionally, although some animals may be confined in some areas, for purposes of this estimation the entire cattle population was assumed to be grazing on pasture areas.

Table 4. Land cover within 100 feet of Turnback Creek and tributaries

Land Cover Type	Riparian Corridor Land Cover Type Area	
	Square Miles	Percent
Developed, Medium Intensity	0.005	0.07%
Developed, Low Intensity	0.056	0.72%
Developed, Open Space	0.253	3.23%
Barren Land	0.012	0.16%
Hay/Pasture	3.662	46.76%
Cultivated Crops	0.043	0.56%
Forest	3.327	42.49%
Shrub and Herbaceous	0.130	1.66%
Wetlands	0.312	3.99%
Open Water	0.029	0.37%
Total	7.831	100.00%

5. Existing Loads and Needed Reductions

5.1 *E. coli* Bacteria

The *E. coli* TMDLs for Turnback Creek and Tributary to Goose Creek are represented by load duration curves that quantify the loading capacities of each water body at all possible flows. Tables 5 and 6 summarize the TMDLs at selected flows and the load reductions that are needed to meet the TMDLs. The load reductions were calculated based on the geometric mean of observed *E. coli* data that exceeded the water quality criterion of 126 cfu/100 mL.

Table 5. Turnback Creek *E. coli* TMDLs and Needed Reductions

Percent of time flow is exceeded	Flow Condition	Flow (cfs)	TMDL (counts/day)	Existing Load (counts/day)	Needed Reduction (counts/day)	Needed Reduction (%)
95%	Low flow	11.76	3.63E+10	2.34E+10	0.00E+00	0.00%
75%	Dry Conditions	26.46	8.16E+10	7.54E+10	0.00E+00	0.00%
50%	Mid-Range	69.12	2.13E+11	4.37E+11	2.24E+11	51.26%
25%	Moist Conditions	162.95	5.02E+11	9.65E+11	4.63E+11	47.98%
5%	High Flow	442.80	1.37E+12	6.38E+12	5.01E+12	78.53%

Table 6. Tributary to Goose Creek *E. coli* TMDLs and Need Reductions

Percent of time flow is exceeded	Flow Condition	Flow (cfs)	TMDL (counts/day)	Existing Load (counts/day)	Needed Reduction (counts/day)	Needed Reduction (%)
95%	Low flow	0.44	1.34E+09	0.00E+00	0.00E+00	0.00%
75%	Dry Conditions	0.98	3.02E+09	4.89E+09	1.87E+09	38.24%
50%	Mid-Range	2.56	7.89E+09	7.83E+09	0.00E+00	0.00%
25%	Moist Conditions	6.04	1.86E+10	4.02E+10	2.16E+10	53.73%
5%	High Flow	16.40	5.06E+10	5.79E+10	7.30E+09	12.61%

5.2 Nitrogen and Phosphorus

Missouri's water quality standards do not establish nutrient criteria for streams. However, nutrient load reductions are a statewide priority, and many of the nonpoint source management measures that reduce *E. coli* loading also reduce nitrogen and phosphorus loading. Excessive nitrogen and phosphorus loading can lower the quality of ground and surface water. In high quantities, nitrogen has the potential to harm animals and humans. Phosphorus leachate or runoff attached to sediment particles entering the surface water contributes to excessive algae growth causing low oxygen levels in surface water that impairs aquatic life and contributes to bad tasting drinking water (NRCS 2013).

Nutrient targets used for load duration curves are based on EPA Region 7 Regional Technical Assistance Group (RTAG) benchmark values. These benchmark values are expected to be protective of Missouri's designated uses, but are not water quality criteria codified in Missouri's Water Quality Standards regulations at 10 CSR 20-7.031. In the absence of Missouri specific nutrient criteria for streams, these targets are provided only as guidance to assist watershed planning activities. Turnback Creek and Tributary to Goose Creek are not currently identified as impaired due to nutrients and no specific nutrient reduction is required for attainment of existing applicable water quality standards. Groups developing their own watershed plans may determine that alternative, scientifically defendable, nutrient targets are appropriate for maintaining or attaining water quality standards. If a TMDL is developed in the future to address nutrient pollution in the water bodies, then the load allocations established in that approved TMDL should serve as the targets for watershed planning and nonpoint source nutrient reduction efforts.

Tables 7 and 8 provide load reductions calculated using the geometric mean of observed total nitrogen and total phosphorous that exceeded the RTAG recommendation of 0.9 mg/L of total nitrogen and 0.075mg/L total phosphorous. The data were collected by USGS and MoDNR at three Turnback Creek monitoring locations from 2000 to 2014.

As displayed on Figures 6 and 7, total nitrogen loads for the watershed across all flow regimes typically exceed the RTAG target value and reductions are needed during all flow conditions. Total phosphorous loads are below RTAG targets across all flow regimes.

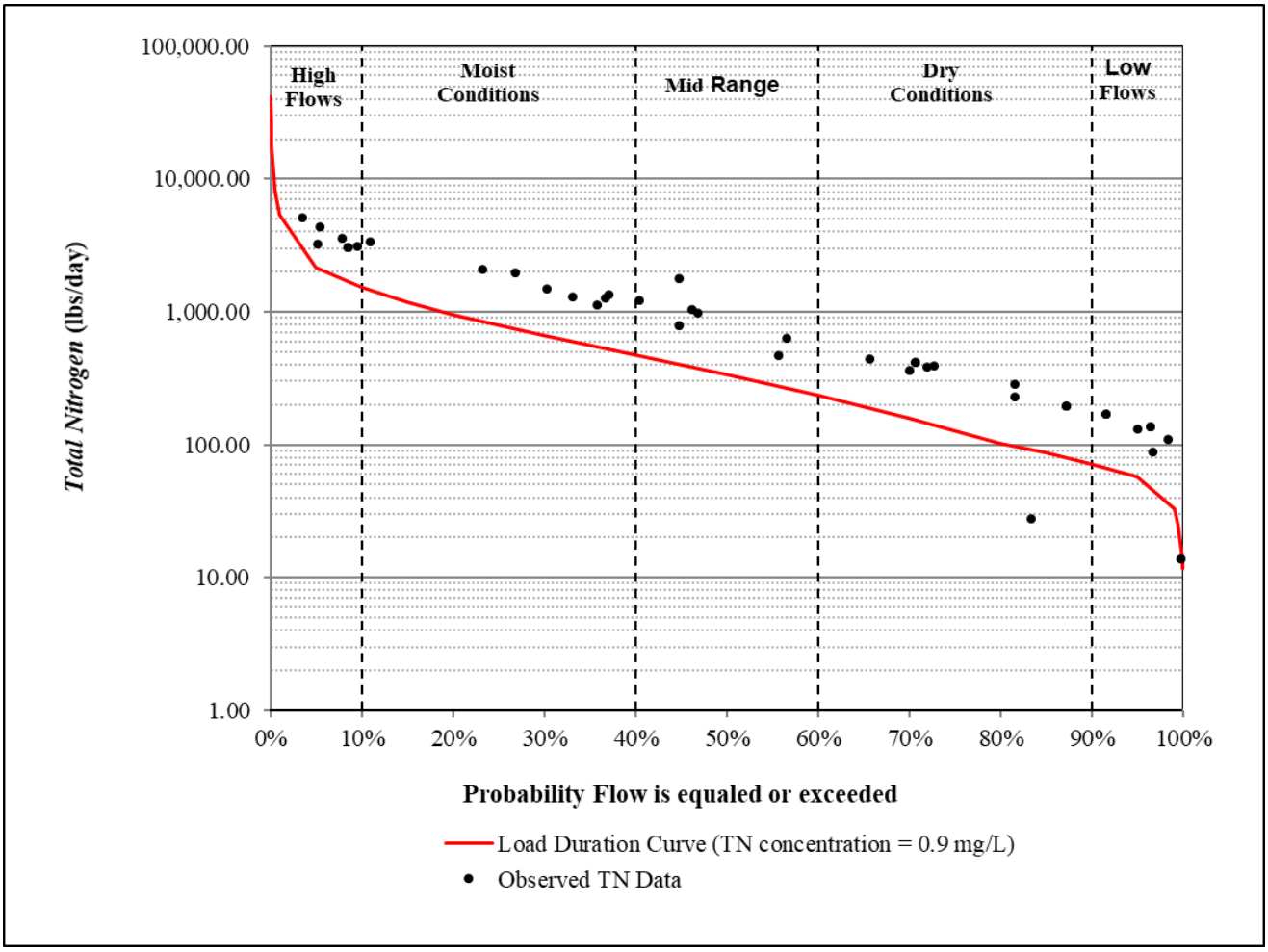

Figure 4. Load duration curve for Turnback Creek total nitrogen targets

Table 7. Total nitrogen target loads and recommended reductions

Percent of time flow is exceeded	Flow Condition	Flow (cfs)	Target Load (lbs/day)	Existing Load (lbs/day)	Needed Reduction (lbs/day)	Needed Reduction (%)	Existing Concentration (mg/L)
95%	Low flow	11.76	57.11	99.27	42.16	42.47%	1.56
75%	Dry Conditions	26.46	128.45	253.87	125.42	49.40%	1.78
50%	Mid-Range	69.12	335.55	911.73	576.18	63.20%	2.45
25%	Moist Conditions	162.95	791.03	1640.13	849.10	51.77%	1.87
5%	High Flow	442.80	2149.62	3581.46	1431.84	39.98%	1.50

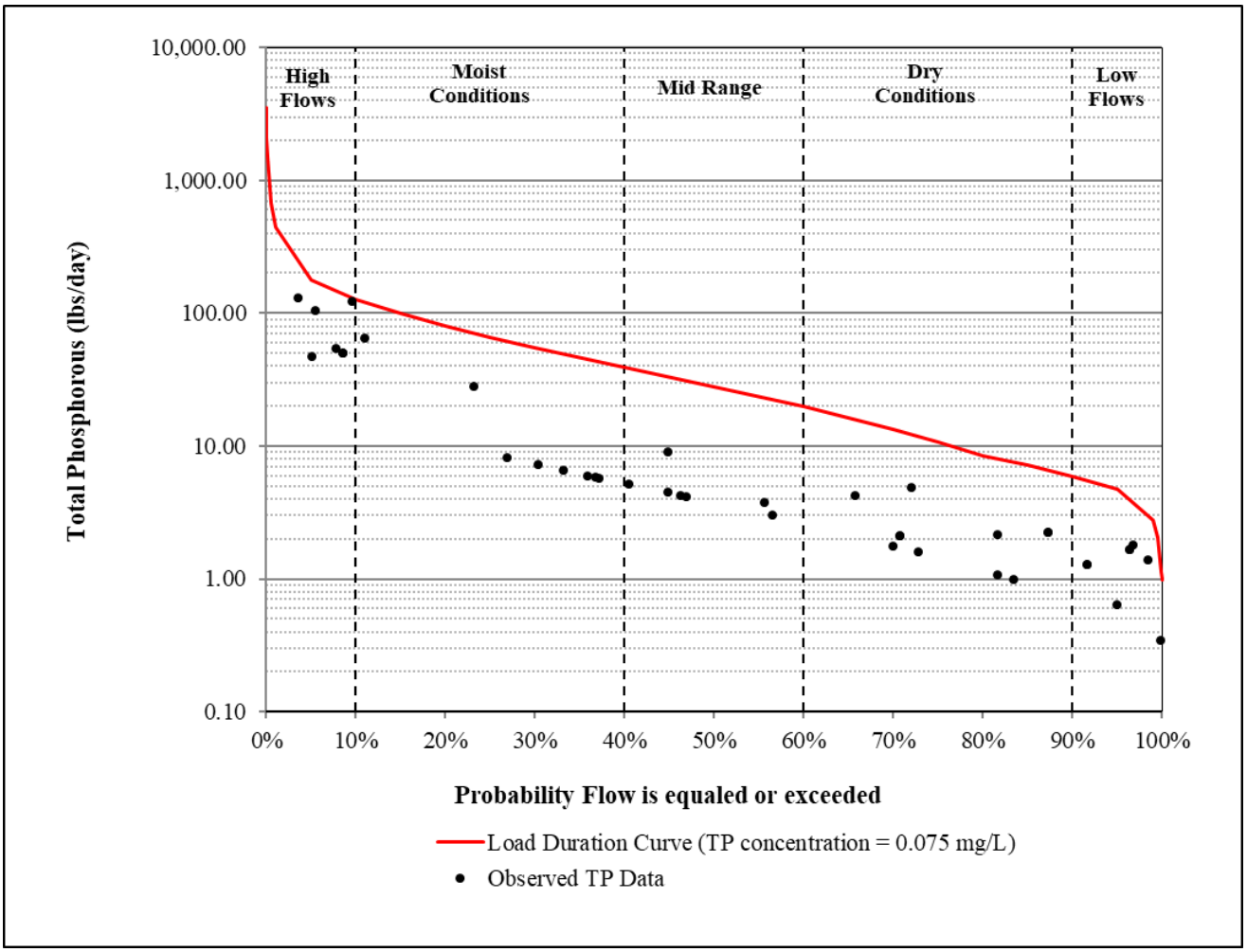

Figure 5. Load duration curve for Turnback Creek total phosphorous targets

Table 8. Total phosphorous target loads and recommended reductions

Percent of time flow is exceeded	Flow Condition	Flow (cfs)	Target Load (lbs/day)	Existing Load (lbs/day)	Needed Reduction (lbs/day)	Needed Reduction (%)	Existing Concentration (mg/L)
95%	Low flow	11.76	4.76	1.12	0.00	0.00%	0.018
75%	Dry Conditions	26.46	10.70	2.07	0.00	0.00%	0.014
50%	Mid-Range	69.12	27.96	4.59	0.00	0.00%	0.012
25%	Moist Conditions	162.95	65.92	10.46	0.00	0.00%	0.012
5%	High Flow	442.80	179.13	72.74	0.00	0.00%	0.030

6. Point Source Implementation

Federal regulations at 40 CFR 122.44(d)(1)(vii)(B) require permit conditions to be consistent with the assumptions and requirements of TMDL wasteload allocations and other recommendations in the TMDL documents. How these conditions are expressed can vary depending upon the pollutant and nature of the discharge. Although TMDLs are required to be written for daily time increments, permit

effluent limits may be written in a form that derives from and complies with applicable water quality standards that use any time measure (40 CFR 122.44(d)(1)(vii)(A) and EPA 2006). The Department's permit writers have discretion for how TMDL wasteload allocations are expressed in a permit and for determining appropriate implementation schedules. Permit writers should consult available permit writing handbooks and technical support documents to determine appropriate limits.[9] Although wasteload allocations are often specified for individual facilities, in some cases, it may be appropriate for pollutant loadings to be shifted between the individual facilities during permitting as long as the sum of the wasteload allocations remains unchanged and the loading capacity is not exceeded. In no case does a TMDL wasteload allocation allow for permit limits that exceed water quality standards. If water quality standard revisions result in criteria more stringent than an established TMDL wasteload allocation, then the more stringent criteria should be used in deriving the permit limits.[10] Information regarding the Department's permitting process is available online at dnr.mo.gov/env/wpp/permits/index.html or by calling the Department's Operating Permit Section at 573-522-4502.

Table 9 lists the types of point sources in the Turnback Creek and Tributary to Goose Creek watersheds that should be addressed in order to achieve the TMDL wasteload allocation targets. As noted in the TMDL, two municipal wastewater discharges are present in these watersheds that are potential contributors of *E. coli* loading. Currently both facilities disinfect their effluent in compliance with appropriate *E. coli* limits or schedules of compliance are provided in state operating permits.

Table 9. Point source discharges found in the Turnback Creek and Tributary to Goose Creek watersheds

Type	Objective	Strategies
Municipal and domestic wastewater dischargers	Meet wasteload allocations assigned in Section 8.1 of TMDL report	• Appropriate *E. coli* permit limits • Disinfection • Consider no discharge options • Reduce occurrences of sanitary sewer overflows
CAFOs	Meet wasteload allocations assigned in Section 8.3 of the TMDL report	• Maintain no discharge • Land apply waste according to permitted conditions • Nutrient management plans to manage manure application rates
Illicit straight pipe discharges	Illegal discharges and therefore should be eliminated from the watershed	• Report known discharges to local county health departments

[9] The Department maintains a Water Pollution Control Permit Manual to provide guidance to permit writing staff and is available online at dnr.mo.gov/env/wpp/permits/manual/. Additionally the EPA maintains a National Pollutant Discharge Elimination System (NPDES) Permit Writers' Manual online at epa.gov/npdes/npdes-permit-writers-manual .

[10] Federal regulations at 40 CFR 131.21, also known as the "Alaska Rule," require water quality standards to be approved by the EPA before they can be used for Clean Water Act purposes (i.e., water quality-based effluent limitations or TMDLs).

7. Nonpoint Source Implementation

7.1 Nonpoint Source Management Activities Previously Implemented

Nonpoint source management measures should focus primarily on reducing *E. coli* and nutrient loading from grassland and pasture lands because loading is typically higher from these areas. Suggested nonpoint source management measures are summarized in the following sections.

7.2 Potential Nonpoint Source Management Measures and Expected Load Reductions

Nonpoint source management measures should focus primarily on reducing *E. coli* and nutrient loading from grassland and pasture lands because these land cover types are most prevalent in the watersheds, particularly in areas adjacent to the impaired water bodies or on lands susceptible to erosion. Suggested nonpoint source management measures are summarized in the following sections. Forty-nine percent of the riparian corridors in the Turnback Creek watershed are covered by pastureland. Focusing on resources on streambank stabilization, riparian buffers, and livestock grazing management can support reductions of *E. coli* and nutrient loading to the impaired stream segments.

7.2.1 Riparian Buffers

Riparian corridor conditions have a strong influence on instream water quality. Wooded riparian buffers are a vital functional component of stream ecosystems and are instrumental in erosion reduction, as well as the detention, removal, and assimilation of pollutants in runoff. Therefore, a stream with good riparian cover is better able to mitigate the impacts of high pollutant loads than a stream with poor or no riparian cover. Shade provided by riparian corridors is also important because it helps to keep water cooler (cold water holds more oxygen) and reduces temperature variation that stresses aquatic life especially during the critical low flows that typically occur in July and August. Riparian corridors that lack woody vegetation should be prioritized for riparian restoration.

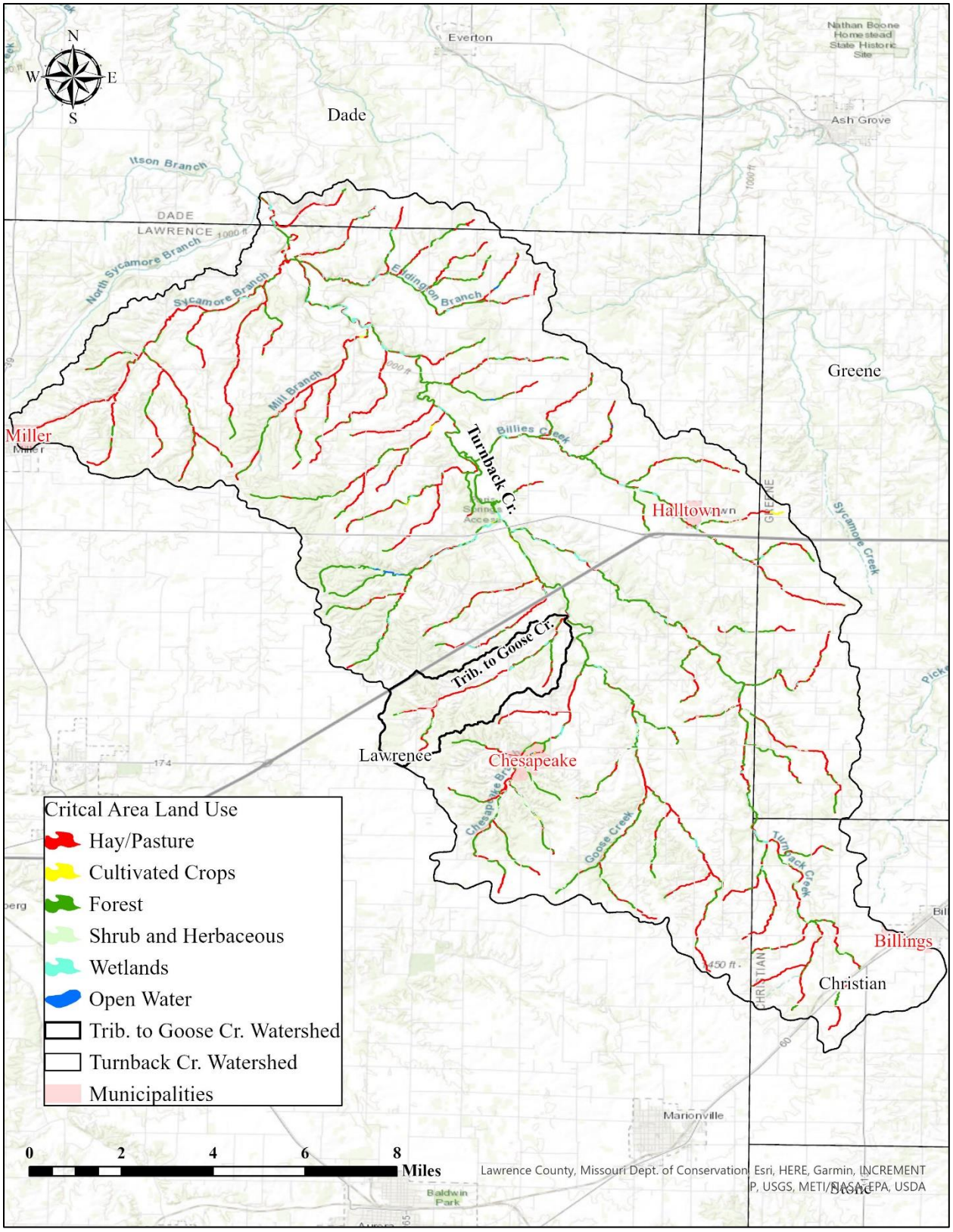

Figure 6. Land Cover and Priority Riparian Corridors adjacent to Turnback Creek and Tributary to Goose Creek

7.2.2 Streambank Stabilization

Streambank stabilization measures also reduce erosion. Such measures may include the installation of live stakes, coconut fiber rolls and mesh, coir rolls, bank terracing, large woody debris, and large boulders to support streambanks and reduce erosion. Integrating shrub and tree planting with other bank stabilization measures results in long-term stabilization as the vegetative roots expand and provide further soil stability. Many resources are available to guide streambank stabilization design for specific conditions. A good initial reference is the *Army Corps of Engineers Streambank and Shoreline Protection Manual* (www.lrc.usace.army.mil/Portals/36/docs/regulatory/pdf/StrmManual.pdf).

A study of bank stabilization on the Cedar River in Nebraska[11] (Naisargi and Mittelstet 2017) found the average streambank erosion rate before stabilization was approximately 1.5 ft^2/ft and was reduced to 0.5 ft^2/ft after stabilization measures were implemented.

[11] The Cedar River watershed is located in North Central Nebraska. The western half of the watershed is mainly grassland and sand dunes in the Sand Hills, whereas the eastern half is predominantly cropland.

7.2.3 Livestock Exclusion

Livestock that have access to streams reduce streamside vegetation, increase barren areas, and contribute *E. coli* and nutrients directly to streams. In addition, compaction from animals contributes to poor quality aquatic habitat because the interstitial spaces in stream substrate are eliminated. Excluding livestock from streams is another way to improve water quality and aquatic habitat in the Turnback Creek and Tributary to Goose Creek watersheds.

7.2.4 Nutrient Management

Nutrient management is the most effective strategy for reducing *E. coli* and nutrient loading from agricultural lands to streams. The *Missouri Concentrated Animal Feeding Operation Nutrient Management Technical Standard* is available online at: dnr.mo.gov/env/wpp/permits/docs/nutrient-management-tech-standard.pdf. The technical standard describes soil and manure testing protocols, manure application criteria including required setback distances from streams, and monitoring requirements. Department staff are available to assist CAFO operators in the development of effective nutrient management plans.

The primary goal of nutrient management is to promote biomass productivity that provides profit for producers while minimizing negative environmental impacts. Over-application of nitrogen and phosphorus above the crop needs will cause these nutrients to accumulate in the soil and increase the potential for losses to the environment. Nutrient management planning minimizes the transport of *E. coli*, nitrogen, and phosphorus to surface and ground water by optimizing fertilizer application rates, timing, and placement, as well as accounting for all sources of nutrients.

Nutrient management plans may be eligible for cost-share programs through the Soil and Water Conservation Program. Nutrient Management Plans should be developed in accordance with the

Natural Resources Conservation Service Standards and Specifications for Nutrient Management (590). Landowner assistance is available through the Lawrence County Soil and Water Conservation Districts.

In general, the following are required to begin nutrient management planning:

- Soil samples, based on a 7-inch depth, shall be taken once every four years, as a minimum, to monitor the phosphorus, potassium, pH and organic matter levels and adjust nutrient application rates as needed. The pH of the soil is important because it has a direct effect on nutrient availability. Follow Iowa State University recommendations and soil testing procedures to develop a crop budget for determining crop nutrient needs. Nitrate testing using the late spring nitrate test and fall corn stalk test can be used to monitor the nitrogen management program. Soil pH levels shall be maintained near 6.5 for corn and soybeans and 6.9 for alfalfa.
- Manure analysis could be completed on an annual basis for percent of solids, total nitrogen, organic nitrogen, available phosphorus, potassium and pH. A more realistic nutrient content can be obtained by using the averages of three or more analysis.
- Soil tests and realistic yield potentials will be used to determine the application rate of manure so as to supply most of the crop nutrient needs through the manure and legume credits. No additional commercial phosphate or potash will be applied on soils testing high or very high in phosphorus and potassium (K). On these fields additional commercial nitrogen will be applied as needed. This will optimize crop yield potential while minimizing nutrient runoff and nitrogen leaching.
- Sensitive areas: Commercial nutrients, manure and organic by-products shall not be applied to frozen, snow covered ground or saturated soil on slopes greater than five percent unless erosion is controlled. Manure and organic by-products shall not be applied within 200 ft. of a stream, lake, agricultural drainage well, or sinkhole unless injected or incorporated within 24 hours.
- Risk Analysis: The phosphorus index will be used to determine fields that are a high risk for phosphorus losses. Conservation and/or management practices will be used to reduce the potential for phosphorus movement off site. Soil tests will be taken every four years to determine changes in phosphorus levels.

The plan should receive periodic review to determine if adjustments or modifications are needed. At a minimum the plan will be reviewed and revised with each soil test cycle.

7.2.5 Cover Crops

Planting cover crops rather than leaving cultivated cropland barren has both economic and environmental benefits. Legume cover crops can reduce fertilizer costs because they contribute nitrogen to soils. Legumes such as vetch and clover convert nitrogen gas from the atmosphere into soil nitrogen that crops can use. This reduces the amount of fertilizer that needs to be purchased and applied. Applying less fertilizer to the topsoil means reduced transport of nutrients to water bodies in the watershed. Cover crops also reduce erosion by holding soil

in place and reducing top-soil crusting. The plant material left behind after cover-cropping increases water infiltration and reduces evaporation. This reduces the amount of nutrient-laden runoff, and the amount of water needed for irrigation. Moisture retention by decaying plant material also helps soils be more resilient to periodic drought conditions.

A study conducted by Zhu et al. (1989) as cited in Sharpley and Smith (1991) found that planting common chickweed, Canada bluegrass, and downy brome on Missouri soybean fields decreased water runoff by an average 44 percent. The study found that nitrogen (as nitrate) loss was reduced by an average 75 percent and soluble phosphorus runoff was reduced by an average 37 percent. Sharpley and Smith (1991) found that planting ryegrass or wheat on peanut crops for 6 months of the year reduced soil loss by an average of 83 percent.

The Missouri Parks, Soils, and Water sales tax program provides grants to cover up to 75 percent of the cost of planting cover crops, alternative crops, and vegetative buffer zones (field borders). The grants are administered through the Missouri Soil and Water Conservation Program.

7.2.6 Field Borders

Field borders can provide a number of conservation benefits, such as reducing soil erosion from wind and water, protecting soil and water quality and providing habitat for wildlife. These habitats, located at the edges of crop fields, can also serve to connect other buffer practices and habitats within the agricultural landscape. The U.S. Department of Agriculture's Farm Service Agency runs a program called the Continuous Sign-up Conservation Reserve Program that provides farmers with rental payments on land set-aside for conservation buffers for a period of 10-15 years. Cost-share payments are also made available to help farmers with the financial burden of establishing the buffers.

8. Public Outreach

Public outreach is a key component of any watershed management plan. Measures to reduce pollutant loading from unregulated nonpoint source areas are implemented voluntarily through cooperation between citizen groups, landowners, government agencies, and funding entities. Support for nonpoint source reduction plans is generated through education and outreach activities designed to inform the public about water quality issues and what can be done to reduce pollutant loading in watersheds. The U.S. Environmental Protection Agency, U.S. Department of Agriculture, Natural Resources Conservation Service, Soil and Water Conservation Districts, Missouri Department of Natural Resources, Missouri Department of Conservation, University of Missouri Extension, and local governments produce educational materials and make them available on their websites. Staff within these agencies are available to assist with public education and provide technical support for watershed plan development.

The following are some activities recommended to develop support and participation for watershed stewardship.

1. Hold meetings and other outreach events to inform private landowners of the available technical support and financial incentives for implementing pollutant reduction strategies.
2. Attend livestock auctions and demonstrations in the local community, and hand-out literature explaining the available technical support and financial incentives for implementing pollutant reduction strategies.
3. Develop small-scale demonstrations of pollutant reduction strategies.
4. Implement a public awareness campaign regarding water quality with public service announcements.
5. Host local watershed festivals.

9. Measurable Milestones

Measurable milestones outline time frames for the incremental implementation of pollutant reduction strategies. Attainable milestones should be established based on available funding and stakeholder participation. For point sources, milestones may be integrated into permits as schedules of compliance to allow time to plan, fund, and construct facility upgrades or implement adaptive management. Nonpoint source pollutant reduction plans should include milestones for public outreach, attaining funding, and the implementation of chosen nonpoint source management measures. In addition, monitoring and adaptive management plans should be developed for vegetation restoration areas to ensure that plants are healthy and will grow and develop into effective *E. coli* and nutrient attenuation areas. Plans that are developed to procure Section 319 subgrants must be renewed every five years to stay eligible for funding. It is good general practice to develop measurable watershed management milestones on 5-year timeframes. Riparian buffer restoration monitoring and adaptive management plans should include annual monitoring and assessment of plant growth and development with a 5 to 7-year goal of vegetation maturity. The annual evaluations allow for adaptive management to ensure that efforts are successful. The following is an example of measurable milestones over a 20-year timeframe.

5-Year Milestones

- Conduct outreach, gain public participation, and explore funding options that will allow pollutant reduction strategies to be implemented.
- Develop a comprehensive watershed management plan and identify key areas for implementation.
- Procure funding and begin implementing strategies such that:
    - Nutrient management plans are developed and implemented on 10 percent of unregulated agricultural lands in the watershed, and
    - Riparian buffers, and fencing protects 10 percent of tributaries to the impaired waters.
    - 2 percent of streambanks are stabilized in key areas.
- Complete annual monitoring and adaptive management to assess the effectiveness of streambank stabilization projects and to ensure that all newly established riparian buffers are progressing toward maturity.

10-Year Milestones

- Continued outreach, public participation, and funding procurement.
- Develop and implement nutrient management plans on 25 percent of unregulated agricultural lands in the watershed,
- Construct riparian buffers, and fencing to protect 25 percent of tributaries to the impaired waters,
- Construct streambank stabilization in 5 percent of key areas, and
- Complete annual monitoring and adaptive management to assess the effectiveness of streambank stabilization projects and to ensure that all previously established riparian buffers are intact and newly established riparian buffers are progressing toward maturity.

15-Year Milestones

- Continued outreach, public participation, and funding procurement.
- Develop and implement nutrient management plans on 50 percent of unregulated agricultural lands in the watershed,
- Construct riparian buffers, and fencing to protect 50 percent of tributaries to the impaired waters,
- Construct streambank stabilization in 7 percent of key areas, and
- Complete annual monitoring and adaptive management to assess the effectiveness of streambank stabilization projects and to ensure that all newly established riparian buffers are effectively attenuating pollutants.

20-Year Milestones

- Continued outreach, public participation, and funding procurement.
- Develop and implement nutrient management plans on 75 percent of unregulated agricultural lands in the watershed,
- Construct bank stabilization, riparian buffers, and fencing to protect 75 percent of tributaries to the impaired waters,
- Construct streambank stabilization in 10 percent of key areas, and
- Complete annual monitoring and adaptive management to assess the effectiveness of streambank stabilization projects and to ensure that all previously established riparian buffers are intact and newly established riparian buffers are progressing toward maturity.

10. Cost-Benefit

Cost-benefit analyses should be conducted during the watershed management planning process to determine the most efficient investments of time, effort, and supplies. Upgrades to point source facilities should consider both the immediate and necessary future capacity of the facility and should be designed based on the best available affordable technology. Costs associated with nutrient management plan implementation and cover crops are relatively minimal because many of the practices are already integrated into the farming system and substantial cost savings are achieved through reducing the need for manure application and chemical fertilizers. Streambank stabilization is the most expensive pollutant reduction strategy but can be limited to key areas to stabilize highly erosive streambanks for the benefit of water quality in all downstream waters.

11. Cooperating Agencies and Funding Sources

Reducing pollutant loading to achieve TMDLs often requires participation and cooperation from government agencies. TMDLs are written to meet applicable water quality standards per federal regulations at 40 CFR 130.7(c)(1). As a result, they are developed without considering citizen interest, available treatment technologies, or costs associated with nonpoint source management measures. Public service staff can assist with outreach and education, provide technical guidance, and direct interested parties to potential funding sources. Some of the available agencies and organizations and their potential roles, including funding avenues, are listed in Table 14. The list is not exhaustive and not intended to compel participation from any organization nor is it meant to exclude any who are not listed but gives a general idea of responsibilities and potential roles in watershed management. The most commonly used sources of funding are low-interest loans through the State Revolving Fund, Section 319 subgrants, and cost-share practices through the state's Soil and Water Conservation Program.

Table 10. Agency Roles and Funding Options

Agency and Roles	**Funding Options**
US Department of Agriculture, Natural Resources Conservation Service www.nrcs.usda.gov/wps/portal/nrcs/site/mo/home/	
Financial assistance and incentives to implement voluntary BMPs	Environmental Quality Incentives Program (EQIP) Regional Conservation Partnership Program (RCPP) Conservation Stewardship Program (CSP) Agricultural Conservation Easement Program (ACEP)
US Department of Agriculture's Farm Service Agency www.fsa.usda.gov/	
Administers a program called the Continuous Sign-up Conservation Reserve Program that provides farmers with rental payments on land set-aside for conservation buffers for a period of 10-15 years. Cost-share payments are also made available to help farmers with the financial burden of establishing the buffers.	Continuous Sign-up Conservation Reserve Program
Missouri Department of Natural Resources dnr.mo.gov/	
Water Protection Program dnr.mo.gov/env/wpp/ Implements federal Clean Water Act regulations including: enforcing National Pollutant Discharge Elimination System (NPDES) regulations through point source facility operation permits, establishing Water Quality Standards, identifying impaired water bodies, and developing TMDLs.	Free volunteer water quality monitoring training and tools

Agency and Roles	Funding Options
Financial Assistance Center dnr.mo.gov/water/business-industry-other-entities/financial-opportunities/financial-assistance-center Provides technical guidance for publicly-owned treatment works and administers low-interest long-term loans to assist with technology and capacity upgrades. The Clean Water State Revolving Fund provides subsidized loans to municipalities, counties, public sewer districts, and political subdivisions for wastewater infrastructure projects. Loans may be paired with grant funds for qualifying communities. Information on the Department's grant policy is available online at dnr.mo.gov/env/wpp/srf/wastewater-assistance.htm. Eligible projects include new construction or improvement of existing facilities.	Clean Water State Revolving Fund
Soil and Water Conservation Program dnr.mo.gov/land-geology/soil-water-conservation The Soil and Water Conservation Program (SWCP) provides financial incentives to landowners to implement practices that help prevent soil erosion and protect water quality. The program offers cost-share practices through its county conservation districts. Landowners may receive up to 75 percent reimbursement of the estimated cost of a practice through the program. The primary funding for cost-share practices from the Soil and Water Conservation Program comes from the one-tenth-of-one percent Parks, Soils, and Water Sales Tax.	SWCP cost-share
Section 319 Nonpoint Source Program dnr.mo.gov/water/what-were-doing/nonpoint-source-pollution-section-319 ▪ Provides assistance with the development of watershed management plans and administers Section 319 subgrants for plan development and implementation.	Section 319 subgrants
Missouri Department of Conservation mdc.mo.gov/	
Provides outreach, education, and technical guidance for stream and watershed management issues. Maintains Missouri Conservation lands. Issues permits for fishing and hunting.	Free volunteer water quality monitoring training and tools
Missouri Agricultural and Small Business Development Authority agriculture.mo.gov/abd/financial/awloanprg.php	

Agency and Roles	Funding Options
Offers an Animal Waste Treatment System Loan Program in cooperation with the Clean Water State Revolving Fund. Animal Waste Treatment Loans Program may finance eligible animal waste treatment systems for independent livestock and poultry producers with operations of less than 1,000 animals. Eligible costs include storage structures, land, dedicated equipment, flush systems, composters, and more.	Clean Water State Revolving Fund
University of Missouri Extension extension2.missouri.edu/	
Provides guidance for farm management including crop resilience, pond health, and livestock care.	Free information and assistance
County Soil and Water Conservation Districts dnr.mo.gov/land-geology/businesses-landowners-permittees/financial-technical-assistance/soil-water-conservation-cost-share-practices	
Provides guidance and assistance with the development of nutrient management plans and procurement of funding from the state cost-share program.	Free information and assistance with grant applications
Online Databases of Additional Funding Sources	
▪ Wichita State University, Environmental Finance Center Missouri Healthy Watershed Funding Search Tool www.wichita.edu/academics/fairmount_college_of_liberal_arts_and_sciences/hugowall/efc/news/meramec-funding-sources-landing-page.php ▪ Catalog of Federal Funding www.epa.gov/waterdata/catalog-federal-funding ▪ EPA Nonpoint Source Funding Opportunities water.epa.gov/polwaste/nps/funding.cfm ▪ Environmental Justice Grants www.epa.gov/environmentaljustice/environmental-justice-grants-and-resources ▪ Grants.gov www.grants.gov	

12. Conclusion

The ultimate goal of pollutant reduction strategies is to meet Missouri Water Quality Standards through the protection of aquatic life in warm water habitats and whole-body contact recreation. Implementation strategies should follow an adaptive approach that makes progress toward achieving water quality goals while using new data and information to reduce uncertainty and adjust implementation activities. Implementation efforts are expected to occur over a number of years, but within the schedules established in state operating permits and watershed management plans. Success in achieving water quality standards will be determined by the Department through biennial assessments of water quality compliance as required by Sections 305(b) and 303(d) of the federal Clean Water Act.

The Department maintains administrative records for the Turnback Creek and Tributary to Goose Creek TMDLs. The records contain the TMDL document, this implementation strategies document,

and any studies, data, or calculations upon which loading targets are based. This information is available upon request to the Department at dnr.mo.gov/sunshinerequests.htm. Any request for information about TMDLs will be processed in accordance with Missouri's Sunshine Law (Chapter 610, RSMO) and the Department's administrative policies and procedures governing Sunshine Law requests.

This implementation strategies document is scheduled for a 45-day public notice and comment period in conjunction with the comment period for the Turnback Creek and Tributary to Goose Creek *E. coli* TMDL document. Any comments received, as well as the Department's responses to those comments, will be maintained on file with the Department and posted online at dnr.mo.gov/water/what-were-doing/water-planning/quality-standards-impaired-waters-total-maximum-daily-loads/tmdls. The Department maintains an email distribution list for notifying subscribers of significant TMDL updates or activities. Those interested in subscribing to these TMDL updates can submit their email address using the online form at public.govdelivery.com/accounts/MODNR/subscriber/new?topic_id=MODNR_177.

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Appendix A
Nine Key Elements Critical to a Watershed Management Plan

a. An identification of the causes and sources or groups of similar sources that will need to be controlled to achieve the load reductions estimated in this watershed-based plan (and to achieve any other watershed goals identified in the watershed-based plan, as discussed in item (b) immediately below. Sources that need to be controlled should be identified at the significant subcategory level with estimates of the extent to which they are present in the watershed (e.g., X number of dairy cattle feedlots needing upgrading, including a rough estimate of the number of cattle per facility; Y acres of row crops needing improved nutrient management or sediment control; or Z linear miles of eroded streambank needing remediation).

b. An estimate of the load reductions expected for the management measures described under paragraph (c) below (recognizing the natural variability and the difficulty in precisely predicting the performance of management measures over time). Estimates should be provided at the same level as in item (a) above (e.g., the total load reduction expected for dairy cattle feedlots; row crops; or eroded streambanks).

c. A description of the nonpoint source management measures that will need to be implemented to achieve the load reductions estimated under paragraph (b) above (as well as to achieve other watershed goals identified in this watershed-based plan), and an identification (using a map or a description) of the critical areas in which those measures will be needed to implement this plan.

d. An estimate of the amounts of technical and financial assistance needed, associated costs, and/or the sources and authorities that will be relied upon, to implement this plan. As sources of funding, States should consider the use of their Section 319 programs, State Revolving Funds, U.S. Department of Agriculture's Environmental Quality Incentives Program and Conservation Reserve Program, and other relevant Federal, State, local and private funds that may be available to assist in implementing this plan.

e. An information/education component that will be used to enhance public understanding of the project and encourage their early and continued participation in selecting, designing, and implementing the nonpoint source management measures that will be implemented.

f. A schedule for implementing the nonpoint source management measures identified in this plan that is reasonably expeditious.

g. A description of interim, measurable milestones for determining whether nonpoint source management measures or other control actions are being implemented.

h. A set of criteria that can be used to determine whether loading reductions are being achieved over time and substantial progress is being made towards attaining water quality standards and, if not, the criteria for determining whether this watershed-based plan needs to be revised or, if a nonpoint source TMDL has been established, whether the nonpoint source TMDL needs to be revised.

i. A monitoring component to evaluate the effectiveness of the implementation efforts over time, measured against the criteria established under item (h) immediately above.

Appendix B

Targeted Participants and Potential Roles in Implementation

The Department implements TMDL targets for point sources through the Missouri State Operating Permit program. For nonpoint sources, private landowners and citizen groups voluntarily implement water quality improvement projects and cost-share practices, which may be funded in part by grants or subgrants from the Department's Section 319 Nonpoint Source Implementation Program and the Soil and Water Conservation Program. Local governments, citizen groups, and individuals who have an interest in improving water quality in their communities may implement additional water quality improvement actions. Successfully meeting the goals of a TMDL often requires participation and cooperation from various parties within a watershed. Participant roles range from technical support to actual on-the-ground implementation of BMPs. Groups and agencies that may potentially be involved in the TMDL implementation process are identified below along with descriptions of their possible roles. This list is not exhaustive and not intended to compel participation from any organizations; nor is it meant to exclude those who are not listed, but may be interested in participating.

- Department of Natural Resources
  - Administers statutory authorities granted by Missouri clean water law
  - Ensures permits issued in the watershed are consistent with the assumptions and requirements of TMDL wasteload allocations (the allowable point source load)
  - Provides compliance assistance to regulated entities
  - Provides technical support to locally-led watershed groups o Serves as a potential source of financial assistance for watershed plan development and BMP implementation through Sections 319(h) and 604(b) grants, or through Soil and Water Program cost-share practices
  - Serves as a potential source of financial assistance for infrastructure improvements through low-interest State Revolving Fund loans
  - Assesses attainment of water quality standards on a biennial basis for federal Clean Water Act Sections 303(d) and 305(b) reporting Implementation Strategies for Turnback and tributary to Goose Creek TMDL
  - Provides education and training to volunteers through the Missouri Stream Team Program
  - Provides technical assistance for market-based approaches to compliance such as water quality trading
- County Soil and Water Conservation Districts
  - Provide financial incentives to agricultural producers to implement conservation practices that help prevent soil erosion and protect water quality
  - Provide technical assistance with design, implementation, and maintenance of conservation practices
- University of Missouri Extension o Provides technical assistance for addressing nonpoint source and watershed management issues
  - Assists with organizing locally led watershed groups
- Missouri Department of Conservation o Provides technical assistance with stream and watershed management issues
  - Promotes maintenance and reestablishment of stable streambanks and functional riparian corridors
  - Missouri Department of Health and Senior Services
  - Provides technical assistance pertaining to onsite wastewater treatment systems (i.e., septic)
- County Health Departments

  - Provide technical assistance pertaining to onsite wastewater treatment systems
- Domestic Wastewater Treatment Facilities
  - Operate in accordance with stated permit limits, conditions and schedules
  - Disinfection technologies
  - May participate in water quality trading implementation (nutrients)
- Operate in accordance with stated permit conditions and schedules
  - May participate in water quality trading implementation
- Locally led watershed groups
  - Develop and implement Section 319-funded nine key element watershed-based plans (See Appendix A)
  - Identify critical areas at a local level
  - Implement BMPs to reduce nonpoint source pollutant loading
  - Provide public education and outreach
- Stream Team volunteers
  - Collect screening level water quality data (i.e., dissolved oxygen and biological monitoring) through the Volunteer Water Quality Monitoring program
  - Provide stewardship, advocacy, and education
  - The Missouri Stream Team Program is a partnership between the Department of Natural Resources and the Department of Conservation.